1 MEASUREMENTS

1. MEASUREMENT OF PHYSICAL QUANTITY

	♦	FUNDAMENTAL UNITS
	♦	DERIVED UNITS
	♦	SYSTEM OF UNITS
	♦	CONVENTIONS FOR WRITING THE SYMBOLS OF UNITS

INTRODUCTION:

Measurement plays an important role in Physics and in our daily life as well. Physics is said to be the science of measurement. Study of physics is absolutely meaningless without measurement. Our day-to-day life is also full of the techniques of measurements.

- When we say that the car is moving at 100 km/h, we measure the speed, when we say that the weightlifter lifts 200 kg, we measure the mass, when we say that it takes 30 minutes to reach to our school, we measure the time etc.
- Measurement of a physical quantity is expressed in terms of some standards knows as units. This chapter makes an attempt to associate a physical quantity with its unit and also some techniques of measurement.
- The study of nature and its laws is called physics.
- Physics is an exact science.
- Physics is basically a science of measurements.
- Measurement should be made for knowing about the quantity of physical quantity.
- The quantities which are measurable are called physical quantities.
  Ex: Length, mass, time, speed, etc.
- Unit is a standard. To measure any physical quantity one standard should be required i.e., called unit.
  Ex: Metre is the standard by which we can measure length.
  unit of length is metre
  Ex: Second is the standard by which we can measure time.
  unit of time is second

➢ The number of times a standard quantity is present in a given physical quantity is called Numerical value of physical quantity.

Physical quantity = Numerical value × Unit

Ex. Let length of table = 3 metre

Here 3 is the Numerical value and metre is the standard unit.

⇒Every physical quantity is expressed as number (N) followed by its unit (U).

P=NU

Where P is the magnitude of the quantity
N is the numerical value and
U is unit of the quantity

⇒ Magnitude of the quantity (P) does not change with the choice of unit.

∴ P is constant ⇒ NU = constant

$$\Rightarrow N_1U_1 = N_2U_2$$

$$N = \frac{P}{U} \Rightarrow \propto \frac{1}{U}$$

(i.e., numerical value of a physical quantity is inversely proportional to unit chosen)

Ex. Height of a boy =1.2 m = 120 cm

In 1.2 m, unit is metre and numerical value is 1.2

In 120cm, unit is centimeter and numerical value is 120

➢ The first serious attempt to standardize the units was made in 1889 in Paris.

➢ A unit should be

i) Well defined

ii) Easily reproduced

iii) Easily accessible

iv) It should not change with time i.e. it should be imperishable.

v) It should be of suitable in size i.e. of convenient size.

vi) It should not be affected by physical conditions like temperature and pressure etc.

vii) It should be easily comparable with other similar units.

Unit: Unit is a standard which is used for the measurement of physical quantity.

FUNDAMENTAL UNITS:

Fundamental units are the units for measuring fundamental quantities. These are independent of other units

Ex: Unit of length - metre
Unit of mass – kilogram
Unit of time - second

These are also called basic units.

DERIVED UNITS:

Derived units are the units of derived physical quantities which are expressed in terms of fundamental units.

Ex: The unit of speed is expressed by dividing the unit of distance by unit of time.

Hence speed is a derived quantity and the unit of speed is derived unit.

The fundamental unit of length, mass and time taken together form a system of units.

SYSTEM OF UNITS:

There are four system of units.

(i) British or F.P.S. system. (ii) French or C.G.S system.

(iii) M.K.S system or metric system. (iv) International system or S.I.

System	Fundamental Quantity		
	Length	Mass	Time
FPS	Foot (ft)	Pound (/b)	Second (s)
CGS	Centimetre (cm)	Gram (g)	Second (s)
MKS	Metre (cm)	Kilogram	Second (s)

➢ S.I. system has seven basic units and two supplementary units.

SI system of unit		
Quantity	**Unit**	**Symbol**
Length	Metre	m
Mass	Kilogram	kg
Time	Second	s
Temperature	Kelvin	K
Luminous intensity	Candela	Cd
Electric charge	Coulomb	C
Amount of substance	Mole	Mole
Supplementary quantities		
Plane angle	Radian	Rd
Solid angle	Steridian	sr

CONVENTIONS FOR WRITING THE SYMBOLS OF UNITS :

1. The symbol for a unit which is not named in the honour of some scientist is written in lower letter.

Ex: The symbol for metre is ‘m’ for kilogram is ‘kg’ and for second as ‘s’.

2. The symbol for a unit which is named in the honour of some scientist is written with initial capital letter.

Ex: The symbol for unit of force (newton) is N. The symbol for unit of temperature (Celsius) is °C. The symbol for unit of work (joule) is J.
The symbol for unit of power (watt) is W.

3. Full name of the unit named in the honour of scientist is written with lower initial letter.

Ex: The full name for the unit of force is newton and not Newton. The full name for the unit of power is watt and not Watt.

4. Negative powers are used for compound units obtained by dividing one unit with another unit.

Ex: The unit of speed is m/s. It is expressed as ms^{-1}.

5. A unit in short form is never written in plural.

Ex: 30 kilogram in short form is written as 30 kg and not 30 kgs.

1. MEASUREMENT OF PHYSICAL QUANTITY

WORK SHEET LEVEL–I MAINS CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

PHYSICAL QUANTITY

1. Physical quantity is equal to
   1) numerical value × physical quantity
   2) numerical value / unit
   3) numerical value × unit
   4) numerical value × $(\text{unit})^2$
2. Among the following, the odd one is
   1) pound 2) quintal 3) ton 4) angstrom
3. 1 unit of time is
   1) metre 2) gram 3) second 4) Kelvin
4. Which of the following is an example of physical quantity?
   1) Weakness 2) Mass 3) Sadness 4) Affection
5. The act of measuring the required quantity is called
   1) Counting 2) Measurement 3) Unit 4) All the above
6. The quantity which is measurable is called a
   1) Physical quantity 2) Not physical quantity
   3) Both (1) and (2) 4) Neither (1) nor (2)

SYSTEM OF UNITS

7. The systems used to measure mass, length and time are
   1) FPS system 2) CGS system 3) MKS system 4) All the above
8. The fundamental unit which is common in C.G.S and S.I System is
   1) meter 2) second 3) gram 4) centimeter
9. Unit of mass in C.G.S system is
   1) gram 2) kilogram 3) centigram 4) milligram
10. Speed is numerically length divided by time, then its unit is
    1) ms 2) s/m 3) ms^{-1} 4) $m^{-1}s^{-1}$

RULES TO BE FOLLOWED IN WRITING UNITS

11. The symbol of unit of force is
    1) N 2) newton 3) F 4) n
12. The symbol for unit of length in M.K.S system is
    1) Metre 2) m 3) M 4) mr
13. The symbol for unit of length in C.G.S system is
    1) centimeter 2) C.M 3) cm 4) Cm

LEVEL–II

PHYSICAL QUANTITY

14. Physical quantity = Numerical value x _____
    1) Standard number 2) Standard unit
    3) Standard value 4) None of these
15. The numerical value of physical quantity (N) is related to the unit of the quantity (U) as
    1) $N \propto U$ 2) $N \propto \frac{1}{U}$ 3) $N \propto U^2$ 4) $N \propto \frac{1}{U^2}$
16. A constant quantity used for comparison during the measurement of unknown quantity is called
    1) Material quantity 2) Standard quantity
    3) Natural quantity 4) None of these

SYSTEM OF UNIT

17. Fundamental units
    1) can be resolved into other units
    2) can't be resolved into other units
    3) sometimes can be resolved sometimes cannot
    4) none of these
18. In S.I system
    1) All derived units are obtained by multiplying (or) dividing the fundamental units
    2) All derived units are obtained by adding the fundamental units
    3) All derived units are obtained by subtracting the fundamental units
    4) All derived units are obtained by squaring fundamental units

LEVEL-III ADVANCED CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

19. Unit of density is
    1) $g\ cm^{-3}$ 2) $g\ cm^{-2}$ 3) g cm 4) $g\ m^3$
20. Choose the odd one out:
    1) Time 2) Electric current
    3) Thermodynamic Temperature 4) Volume
21. Electric current is a _____
    1) Derived quantities 2) Fundamental quantities
    3) Both 1 and 2 4) None of these
22. Which of the following belongs to derived quantities
    1) Force 2) Acceleration 3) mass 4) Both (1) and (2)

23. The unit of speed is a
1) Fundamental unit 2) Derived unit
3) Neither of above 4) cannot say

STATEMENT TYPE QUESTIONS

24. Statement I: Derived unit is independent unit.
Statement II: It is derived from fundamental units.
1) Both Statements are true.
2) Both Statements are false.
3) Statement I is true, Statement II is false.
4) Statement I is false, Statement II is true.

25. Statement I: For a physical quantity U_1, U_2 are units N_1, N_2 are their numerical values in different systems. If $N_1 > N_2$ then $U_1 < U_2$
Statement II: The numerical value of a physical quantity is inversely proportional to its unit.
1) Both statements are true.
2) Both statements are false.
3) Statement I is true. Statement II is false.
4) Statement I is false. Statement II is true.

INTEGER TYPE QUESTIONS

26. Amount of work done is 9 joule, here _____ stands for Numerical value

LEVEL-IV

MULTI CORRECT ANSWER TYPE QUESTIONS

27. In F.P.S system the units of fundamental units are
1) Foot 2) pound 3) second 4) feet

28. A standard unit must be
1) Easily definable
2) Easily reproducible
3) must not affected by temperature variations
4) must change with change in length of the instrument

COMPREHENSION TYPE QUESTIONS

PASSAGE

Unit is a standard which is used for the measurement of physical quantities fundamental units are the units for measuring fundamental quantities and derived units are the units for measuring derived quantities.

29. Which of the following are derived quantities
1) speed 2) velocity 3) perimeter 4) Both (1) and (2)

30. Which of the following quantities are used to derive the quantity density
1) Mass 2) Area 3) Volume 4) Both (1) and (3)

31. Which of the following are fundamental quantities
1) Length 2) Height 3) Radius 4) All of these

MATRIX MATCH TYPE QUESTIONS

32.

Column-I	Column-II
a) Derived unit	p) Height
b) Fundamental unit	q) Thickness
c) Derived quantity	r) Area
d) Fundamental quantity	s) Newton
	t) Kilogram

33.

Column-I	Column-II
a) Energy	p)coulomb
b) Frequency	q) watt
c) Charge	r) hertz
d) Power	s) erg
	t) joule

2. MEASUREMENT OF LENGTH AND AREA

	♦	MEASUREMENT OF LENGTH
	♦	MULTIPLES AND SUB-MULTIPLES OF METRE
	♦	MEASUREMENT OF AREA
	♦	MEASUREMENT OF AREA OF REGULAR SURFACE
	♦	AREAS OF SOME REGULAR BODIES
	♦	MEASUREMENT OF AREA OF AN IRREGULAR FLAT SURFACE

MEASUREMENT OF LENGTH

Observe the following:

Here, we are measuring the distance between two points A and B. This distance between two points is called Length.

Standard Unit of Length: According to SI system of units, the standard unit of length is metre. In short form it is written as m.

MULTIPLES AND SUB- MULTIPLES OF METRE:

Multiple of metre: The distance between Amritsar and New Delhi is 470,000 metre. But it is far more convenient to say that the distance between Amritsar and New Delhi is 470 kilometre. Here the word kilo stands for one thousand and represented with a letter k. i.e., 1 kilometre = 1000 metre or 1km = 1000 m

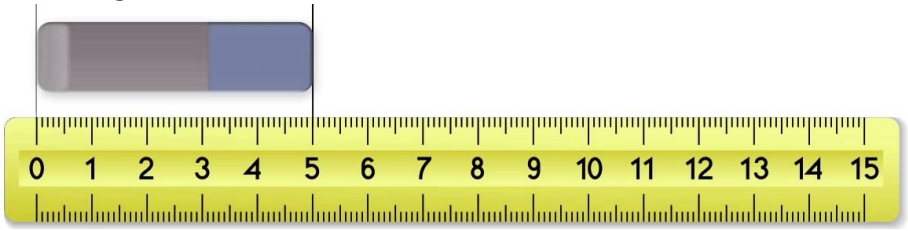
Kilo is used to replace 1000 and is called Prefix. $10^3$is called the multiple.

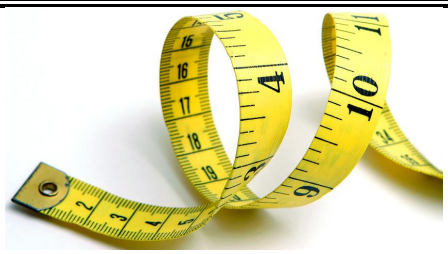
Submultiple of metre: Some lengths are much smaller than a metre. For example, the length of a pencil is 0.15 metre. It is far more convenient to say that the length of a pencil is 15 centimetre. Here, centi stands for 0.01 and represented with a letter **c**.

$$0.01\ \text{m} = \frac{1}{100}\ \text{m} = 10^{-2}\text{m} = 1\ \text{cm}$$

Centiis used to replace 0.01 and is called Prefix. $10^{-2}$is called sub multiple.

Measuring Instruments of length: Ruler, Tape are some instruments used to measure length.





Conversion of units: To convert a unit from one system to another, the steps to be followed are:

Step-1: First convert the given unit into SI unit.

Step-2: Then, convert it into the desired system of units.

Note: Conversion is possible only between the units used to measure the same physical quantity.

CONVERT THE FOLLOWING OF LENGTH INTO DESIRED UNITS

a) Convert 20 cm into meter;

Step 1: $20\text{ cm} = 20 \times 10^{-2}\text{ m} = 0.2\text{ m}$

b) Convert 20 cm into km;

Step 1: $20\text{ cm} = 20 \times 10^{-2}\text{m} = 0.2\text{ m}$

Step 2: $0.2\text{ m} = 0.2 \times 10^{-3} \times 10^{3}\text{ m}$

$= 0.2 \times 10^{-3}\text{ km}$

c) Convert 20 cm into μ m;

Step 1: $20\text{ cm} = 20 \times 10^{-2}\text{m} = 0.2\text{ m}$

Step 2: $0.2\text{ m} = 0.2 \times 10^{6} \times 10^{-6}\text{ m}$

$= 0.2 \times 10^{6}\,\mu\text{m}$

d) Convert 20 cm into nm;

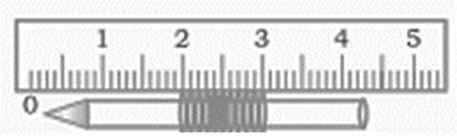
Step 1: $20\text{ cm} = 20 \times 10^{-2}\text{ m} = 0.2\text{ m}$

Step 2: $0.2\text{ m} = 0.2 \times 10^{9} \times 10^{-9}\text{ m}$

$= 0.2 \times 10^{9}\text{ nm}$

Note: 12 inches = 1 foot; 3 feet = 1 yard; 5 ½ yards = 1 pole or rod; 4 pole = 1 chain; 80 chain = 1 mile

Measuring the diameter of wire using scale: Take the wire whose diameter has to be measured. Wind it around the pencil as shown in figure.



See that there is no gap between the turns of wire. Measure the length of coil. For example, if the number of rounds wound are 24 and the length of coil is 4.8cm, then the diameter of wire is length of the coil / number of rounds wound = 4.8/24 = 2mm.

MEASUREMENT OF AREA

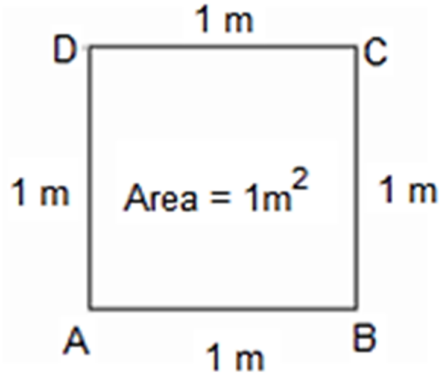
Observe the laptop kept on the table.

Here, the laptop occupies some place on the table. This place occupied by the laptop is called areaof the laptop.

Definition: The amount of surface occupied by an object or a place is called its area.

Units of Area: In Standard International (S.I.) system the unit of area is square metre. In short form square metre is written as m^2.

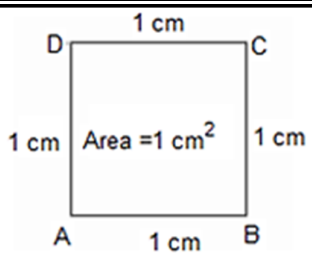
The area of a square surface having each side equal to one metre is called square metre (m^2). Figure shows a square surface ABCD, such that AB = BC = CD = AD = 1 m.



The area of the surface enclosed by ABCD (not drawn to scale) is $1m^2$.

The area of the surface enclosed by ABCD (not drawn to scale) is $1m^2$.

Sub – multiples of standard Unit of Area: 1 square centimetre (1 cm^2) is the submultiple of standard unit of area. The area of square surface having each side equal to 1 cm is called square centimetre (1 cm^2)



The relation between cm^2 and m^2:

$1m^2 = 1\ m \times 1m = 100\ cm \times 100\ cm = 10000\ cm^2$ or $10^4 cm^2$, $1m^2 = 10^4 cm^2$ or

$$1\ cm^2 = \frac{1}{10000}\ m^2 = 10^{-4} m^2$$

Note: Millimeter square is another important submultiple of standard unit of area.

$1mm^2 = 1mm \times 1mm$

$$= \frac{1}{10} cm \times \frac{1}{10} cm = \frac{1}{100} cm^2$$

$$= \frac{1}{10^2} cm^2 = 10^{-2}\ cm^2$$

Multiples of Standard Unit of Area:

For measuring bigger areas, such as area of field or towns, metre square is a very small unit. Thus, a bigger unit is used, which is called hectare. One hectare is the surface area of a square whose each side is equal to 100 m.

Note: 100m is called hectometer and 1 square hectometer is called hectare. 1 square hectometer = 1 hectometer x 1 hectometer = 100m x 100m $=10000m^2$

$100m^2$ is called acre.

$\because$ 1 hectare = 100 acres

$= 100 \times 100m^2 = 10^4\ m^2$.

1 hectare = 100 m x 100 m, 1 hectare = 10000 m^2

(or)

$$1m^2 = \frac{1}{10000} \text{hectare} = 10^4 \text{ hectare}$$

For measuring further bigger areas, such as the area of district or a province or a country, even hectare is a very small and inconvenient unit. Thus, a bigger unit is used which is called square kilometre (km^2).

One square kilometre (km^2) is the surface area of a square whose each side is equal to 1 km. 1 km^2=1000 m × 1000 m, 1 km^2 = 1000, 000 m^2, 1 km^2 = 100 hectares

CONVERSION:

Convert the following units of 'area' into the required units.

a) Convert 20 cm^2 into m^2; 20 cm^2

= 20 x $(10^{-2}\ m)^2$ = 20 x $10^{-4}\ m^2$

b) Convert 15 mm^2 into cm^2; 15mm^2

= 15 x $(10^{-3}\ m)^2$ = 15 x $(10^{"6}\ m^2)$

= 15 x 10^{-6} $(10^2 cm)^2$ = 15 x 10^{-6} x 10^4 cm^2

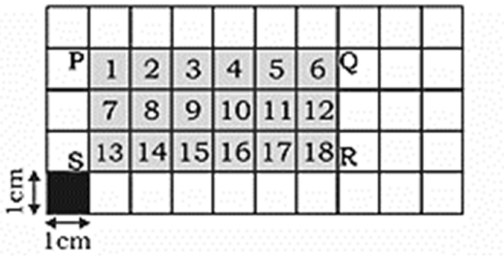
= 15 x 10^{-2} cm^2

c) Convert 20 sq.cm into sq.km. 20 cm^2

= 20 $(10^{-2}\ m)^2$= 20 x 10^{-4} x 10^{-6} x km^2

= 2 x 10^{-9} km^2

MEASUREMENT OF AREA OF A REGULAR SURFACE: Suppose you want to measure the area of a rectangular cardboard of length 6 cm and breadth 3 cm as shown in figure. The convenient unit to measure the area of given cardboard should be cm^2.



Measuring the area of rectangular by using cardboard &centimetre graph paper: Take a centimetre graph paper. Each small square on this graph paper has a side equal to 1 cm.

Thus, the area of each small square on this graph paper is 1 cm^2 as illustrated in figure.

Place the cardboard PQRS on the centimetre graph paper and draw its outline with the help of a sharp pencil. Now remove the cardboard. Count the number of squares within the outline PQRS. The number of squares are 18.

∴Area of the face of cardboard PQRS = Area of 18 small squares = 18 x area of 1 small square

= 18 x 1 cm^2 = 18 cm^2 ——— (1)

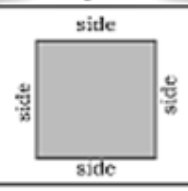
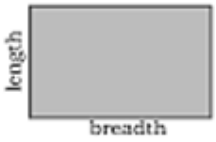
Notice that the length of the cardboard is 6 cm and its breadth is 3 cm. If we multiply length by breadth then:

Length x Breadth = 6 cm x 3 cm

= 18 cm^2 — (2)

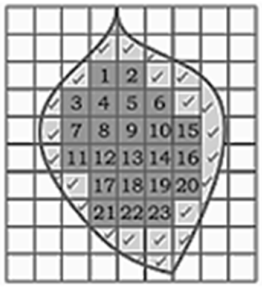
If we compare (i) and (ii) then we can say that Area of the cardboard PQRS = Length x Breadth

AREAS OF SOME REGULAR BODIES:

S.No	Regular body	Figure	Formula
1	Square		side x side
2	Rectangle		Length x breadth
3	Triangle		1/2 x base x height
4	Circle		π x square of radius

MEASUREMENT OF AREA OF AN IRREGULAR FLAT SURFACE

Suppose we want to find the area of the face of a big leaf, such as a people leaf or banyan leaf.



Measuring the area of face of a leaf

Place the leaf flat on the centimetre graph paper. With the help of sharp pencil mark the outline of the leaf. Count the number of complete squares (each of 1 cm^2 area) inside the boundary. Also count those squares, inside the boundary, which are half or greater than half. Add this to the number of complete squares. This total number of squares inside the boundary gives the area of the leaf. If there are 'n' squares inside the boundary, the area of the leaf becomes n

cm^2. Neglect those squares, inside the boundary, which are less than half. This process will gives us the value of area which is close to the actual area.

SOLVED EXAMPLES

1. A school hall measures 20m in length and 12m in breadth. Find the area of the school hall.

Sol. Length of the school hall (l) = 20m
Breadth of the school hall (b) = 12m
Area of school hall = length × breadth (l × b) = 20 m × 12m = $240m^2$
Therefore, the area of the school hall is $240m^2$.

2. The volume of a rectangular slab is $12cm^3$. The length and breadth of the slab are 3cm and 2cm respectively. Find its height.

Sol. Volume (v) = $12cm^3$
Length (l) = 3cm
Breadth (b) = 2cm
Height (h) = ?
Volume = length × breadth × height
$12cm^3$ = 3cm × 2cm × height
$12cm^3$ = $6cm^2$ × height

$$\text{Height} = \frac{12cm^3}{6cm^2} = 2cm$$

Therefore, the height of the rectangular slab is 2cm.

2. MEASUREMENT OF LENGTH AND AREA

WORK SHEET LEVEL–I MAINS CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

MEASUREMENT OF LENGTH

1. The advantage of using a scale is
   1) It can be easily taken from one place to another
   2) It does not change during measurements
   3) It is flexible
   4) Both (1) and (2)
2. The most appropriate unit to measure the length of a book is
   1) Millimeter 2) Meter 3) Micrometer 4) Centimeter
3. The appropriated device used to measure the length of a hall is
   1) Meter scale 2) Measuring tape 3) Centimeter scale 4) None of these
4. The distance between any two points is called
   1) Mass 2) Length 3) Velocity 4) Weight

MEASUREMENT OF AREA

5. The amount of surface occupied by an object is
   1) Length 2) Temperature 3) Area 4) Volume
6. Area of an irregular body (like leaf) can be measured by using a
   1) Thread 2) Scale 3) Graph paper 4) Stone
7. In order to find the area of a rose leaf the best option is
   1) Centimeter graph paper 2) Inch graph paper
   3) Millimeter graph paper 4) Meter graph paper

MULTIPLE AND SUBMULTIPLES OF FACTORS

8. Which is the multiple of standard unit of area?
   1) hectare 2) Centimeter 3) Square kilometer 4) Both 1 and 3
9. Which is not a submultiple of standard unit of area?
   1) square kilometer 2) centimeter
   3) millimeter 4) micron
10. 1 centimetre=_____metre.
    1) 10 2) 1/100 3) 1/1000 4) 1/10,000
11. 1 millimetre=_____metre.
    1) 1/10 2) 1/100 3) 1/1000 4) 1/10000
12. 1 km^2 = _____ hectares
    1) 10000 2) 1000 3) 100 4) 10

LEVEL–II

MEASUREMENT OF LENGTH

13. The smallest division on the meter scale is
    1) 10 mm 2) 2mm 3) 1 mm 4) 5 mm
14. The length of a room is 6 m, 70 cm. This is the same as _____cm
    1) 670 2) 760 3) 690 4) 640

MEASUREMENT OF AREA

15. A School hall measures 20 m in length and 12 m in breadth. The area of school hall is
    1) 1.666 m^2 2) 240 m^2 3) 8 m^2 4) 32 m^2
16. The appropriate unit to measure the area of a football ground is
    1) m^2 2) cm^2 3) hectare 4) mm^2
17. The appropriate unit to measure the area of a notebook is
    1) cm^2 2) mm^2 3) m^2 4) km^2
18. The area of circular shaped football ground of radius 200 m is
    1) 40000π 2) 400π 3) 40π 4) 4000π
19. $20cm^2$ =_____km^2
    1) 2×10^{-8} 2) 2×10^{-9} 3) 2×10^{-4} 4) 2×10^{-2}

MULTIPLE AND SUBMULTIPLES OF FACTORS

20. 1nm = _____
    1) $10^{9}m$ 2) $10^{-7}m$ 3) $10^{-7}cm$ 4) $10^{-9}cm$
21. How many centimeters make 1 nano meter?
    1) $10^{-15}cm$ 2) $10^{-10}cm$ 3) 10^{-8} cm 4) $10^{-7}cm$

LEVEL-III ADVANCED CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

22. The area of the town is 20 hectare, then the area in km^2 is
    1) $0.2km^2$ 2) $2km^2$ 3) $200km^2$ 4)$2000km^2$
23. Find the area of a triangle of base 10cm, and height 5m?
    1) $25m^2$ 2) $25cm^2$ 3) $0.25m^2$ 4) $0.2m^2$
24. The area of a triangle whose base = 4m, height = 6m is
    1) $12m^2$ 2) 12m 3) 12cm 4) $12cm^2$
25. Find the area a of the circular football ground of diameter 800m.
    1) $64\pi \times 10^4 m^2$ 2) $16\pi \times 10^4 m^2$ 3) $4\pi \times 10^4 m^2$ 4) $8\pi \times 10^4 m^2$

26. The length of the school playground is 500m and breadth is 2000cm, then the area of the playground is:
1) $10^4 m^2$ 2) $10^4 cm^2$ 3) $10^4 km^2$ 4) $10^4 mm^2$

27. Find the area of the square of side 20m?
1) 400 km^2 2) 400 cm^2 3) 400 mm^2 4) 4 x 10^{-4} km^2

STATEMENT TYPE QUESTIONS

28. Statement I: 1 km^2 = 1,000,000 m^2
Statement II: Area can be measured in hectare.
1) Both statements are true.
2) Both statements are false.
3) Statement I is true. Statement II is false.
4) Statement I is false. Statement II is true.

INTEGER TYPE QUESTIONS

29. 1 m^2 = 10^n cm^2.The value of n is___

LEVEL-IV

MULTI CORRECT ANSWER TYPE QUESTIONS

30. Choose the correct statement
1) In standard international system the unit of area is square metre.
2) In short form square metre is written as metre square.
3) Metre square is a very small unit of area.
4) Hectare is a bigger unit of area.

31. 1 cm^2 = _____
1) $\frac{1}{10000} m^2$ 2) 10^{-5} m^2 3) $\frac{1}{100000} m^2$ 4) 10^{-4} m^2

COMPREHENSION TYPE QUESTIONS

PASSAGE

To convert a unit from one system to another, the steps to be followed are:
a. First convert the given unit into S.I unit
b. Then, convert it into the desired system of unit

32. 1 km^2 = _____
1) 1 hectare 2) 10 hectare 3) 100 hectare 4) 1000 hectare

33. 1 litre =
1) 1000 ml 2) 1000 cc 3) both 1 and 2 4) None

34. 1 cm^2 = _____
1) 10^{-10} km^2 2) 10^{-8} hectares 3) 10^{-4} m^2 4) All of these

MATRIX MATCH TYPE QUESTIONS

35.

Column-I	Column-II
a) Area of square	p) side x side
b) area of rectangle	q) length x breadth
c) area of triangle	r) ½ x base x height
d) area of circle	s) π x square of radius
	t) π x radius

3. MEASUREMENT OF MASS AND VOLUME

	♦	MEASUREMENT OF MASS
	♦	MULTIPLES AND SUB MULTIPLES OF KILOGRAM
	♦	MEASUREMENT OF TIME
	♦	MEASURING OF VOLUME

MEASUREMENT OF MASS

Imagine you have to buy vegetables from the market.
Here, the measuring quantity is **mass**.

The quantity of matter contained in the body is called its mass. In S.I. system mass is measured in kilogram.

Standard unit of mass: According to SI system of units, the standard unit of mass is kilogram. In short form it is written as kg.

Physical Balance

Simple Balance

MULTIPLES AND SUB MULTIPLES OF KILOGRAM:

Multiple of kilogram: For stating the mass of heavier bodies a bigger unit is used. It is called Quintal. The relation between Quintal and Kilogram is 1Quintal = 100 kilogram

Sub multiple of kilogram: For stating the mass of bodies less than one kilogram, another unit is used. It is called gram. In short form it is written as g.

The relation between gram and kilogram is One gram $=\frac{1}{1000}$ kilogram

Measuring Instruments of mass: Simple balance, Physical balance etc., are some instruments used to measure mass.

Conversions: Convert the following units of 'mass' into desired units

a) Convert 300 g into kg; **Step 1:** $300\ g = 300 \times 10^{-3}\ kg = 0.3\ kg$

b) Convert 5 mg into kg; **Step 1:** $5\ mg = 5 \times 10^{-3}\ g$

Step 2: $5 \times 10^{-3} \times 10^{-3} kg = 5 \times 10^{-6}\ kg$

c) Convert 400 kg into mg;

Step 1: $400\ kg = 400 \times 10^{6} \times 10^{-6}\ kg = 400 \times 10^{6}\ mg$

Now you have enough practice. From now onwards combine the two steps.

d) Convert 5 μ g into ton; $5\ \mu g = 5 \times 10^{-6}\ g = 5 \times 10^{-9}\ kg$

$5 \times 10^{-9}\ kg = 5 \times 10^{-9} \times 10^{-3}\ ton = 5 \times 10^{-12}\ ton$

e) Convert 10 quintal into ng; $10\ quintal = 10 \times 10^{2}\ kg$

$10 \times 10^{2}\ kg = 10 \times 10^{2} \times 10^{3}\ g = 10 \times 10^{2} \times 10^{3} \times 10^{9} ng = 10^{15} ng$

MEASUREMENT OF TIME:

Imagine every day, after coming from school, you start playing at 5 PM. Here, the measuring quantity is Time.

Standard Unit of Time: According to SI system of units, the standard unit of time is **second**. In short form it is written as **s**.

Other Units of time

1 minute (min) = 60 seconds	1 hour (h) = 60 minutes = 360 seconds
1 day = 24 hours	1 year = 365 $\frac{1}{4}$ days
1 decade = 10 years	1 century = 10 decades
1 leap year = 366 days	1 millennium=100 decades = 1000 years

Measuring Instruments of Time: Watches and clocks are some instruments used to measure time.

Wrist watch Table clock Wall clock

Conversions: Convert the following units of 'time' into desired units.

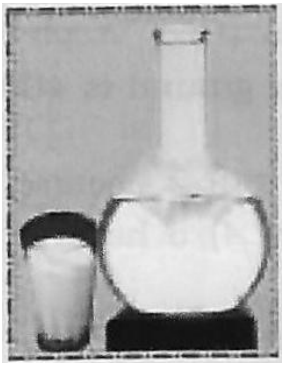
a) Convert 32 s into ms; 32 s = $32 \times 10^3 \times 10^{-3}$ s = 32×10^3ms.

b) Convert 40 min in to μ s; 40 min = 40 × 60 s = 24×10^2 s = $24 \times 10^2 \times 10^6 \times 10^{-6}$s = 24×10^8 μ s

c) Convert 1day into seconds; 1day = 24hrs = 24×60min = 24×60×60s = 86,400s

MEASURING OF VOLUME

Observe the following:

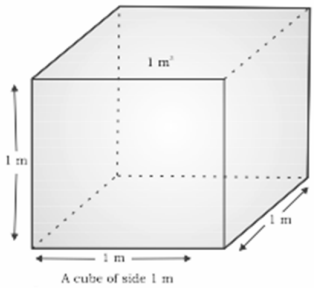


Here, we say that quantity of milk or space occupied by the milk in the big vessel is more when compared to the quantity of milk or space occupied by the milk in the glass. This space occupied by the milk is called volume of the milk.

Volume: The space occupied by a substance (solid, liquid or gas) is called volume.

Units of volume: The unit of volume in standard international (SI) system is cubic metre. In shortform cubic metre is written as m^3.

One cubic metre ($1m^3$) is the volume occupied by a cube whose each side is equal to 1 m.



A cube of side 1 m

Submultiples of unit of volume: Cubic metre is a fairly inconvenient unit for measuring small volumes such as volume of a match box or volume of a glass full of water. A small unit called cubic centimeter (cm^3) is used for measuring small volumes.

The C.G.S unit of volume is cm^3 or cc. Which is used for measuring small volumes. One cubic centimeter ($1cm^3$) is the volume occupied by a cube whose each side is equal to 1 cm.

Relation between 1 m^3 and 1cm^3

1 m^3 = 1 m × 1 m × 1 m

1 m^3 = 100 cm × 100 cm × 100 m

1 m^3 = 1000,000 cm^3 or 1cm^3 = $\frac{1}{1000,000}m^3$

Convert the following units of 'volume' into desired units.

i) Convert 20 cm^3 into m^3

$20cm^3 = 20\times\left(10^{-2}m\right)^3 = 20\times10^{-6}m^3$

ii) Convert 0.2 m^3 into km^3

$0.2m^3 = 0.2\times\left(10^{-3}km\right)^3 = 0.2\times10^{-9}km^3 = 2\times10^{-10}km^3$

$1m^3 = 1\times\left(10^3mm\right)^3 = 1\times10^9mm^3 = 10^9mm^3$

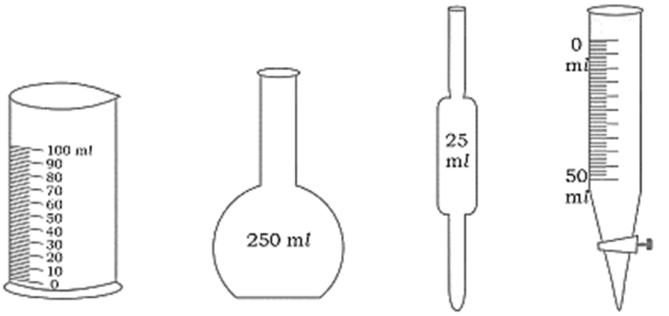
Measurement of volume of liquids: The volume of liquids is generally measured in litres(symbol *l*), the sub-multiple of one litre is millilitre(symbol ml)

1(*l*) = 1000 ml.

One millilitre is also equal to one cubic centimeter (1 cm^3 or 1 cc).

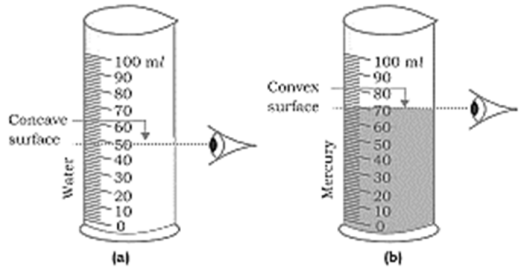
1(*l*) = 1000 m*l* = 1000 cc or 1000 cm^3

The volume of a liquid is measured using a container of known capacity. The space (volume) inside the container is known as its capacity.



(a) measuring cylinder (b) Measuring flask (c) Pipette (d) Burette

For measuring the volume of liquids, different kinds of measuring vessels are used. Some of these vessels are shown in figure. To find the volume of a given liquid, it is poured in the graduated cylinder. The volume of liquid is read from the level of liquid in the graduated cylinder. However, if you observe the level carefully, it is not plane. In case of liquids which wet the sides of graduated cylinder, such as water; alcohol, etc. the level is concave as in figure. We have to look at the mark which appears to touch lowest level of concave surface. Where should we keep our eye? We must keep our eye level just in line with the lowest level of concave surface.



If we keep the eye level above the lowest level of concave surface, then we are likely to read more volume. Similarly, if we keep the eye level below the lowest level of concave surface we are likely to read lesser volume. Some liquids like mercury do not wet the sides of graduated cylinder. They form convex surface rather than concave surface as shown in figure. In such liquids the eyelevel should coincide with the uppermost point of the convex surface.

Measuring Jar: It is cylindrical in shape, with graduations marked on its transparent body. Measure jars are available in different capacities. It is used in laboratories to measure any desired volume of liquids.

Litre Measure: It is a metallic cylinder with a long vertical handle. Its capacity is marked on it. Such similar measures are also available in different shapes with capacities ranging from 50 ml. to 1 litre (1000 ml.). These devices are used for measuring milk, kerosene, oil, petrol etc., in daily life.

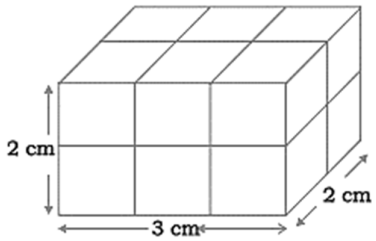
Pipette: It consists of a cylindrical bulb in the middle, to which a tube with nozzle is attached at one end and another tube with a circular marking attached at the other end. The circular marking is positioned such that the volume of the liquid from the tip of the nozzle to the circular marking is having a specified value (say 10cc, 20cc,etc.)

The liquid is filled in the pipette by suction upto the circular mark. It is used in laboratories to take specified measure of liquid.

Burette: It is a graduated, cylindrical glass-tube provided with a stopclock and narrow outlet (nozzle). This is used in laboratories for measuring the quantity of a liquid discharged. The unit of volume in liquids is "litre". Millilitre is its sub-multiple (1000 ml. = 1 litre).

Measurement of volume of a rectangular glass slab (A regular body): Suppose we want to find the volume of a rectangular slab of length = 3 cm, breadth= 2 cm and height = 2 cm as shown in figure. The most convenient scalar for finding volume is cm^3.

Take one dozen 1 cm^3 blocks. Place three 1 cm^3 blocks in a line so as to make the length of 3 cm. behind this line place another line of three, 1 cm^3 blocks. This will make the length of block 3 cm and breadth 2 cm as shown in figure. However, the height of the block is 1 cm only.

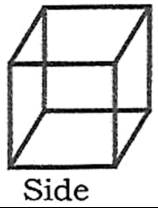
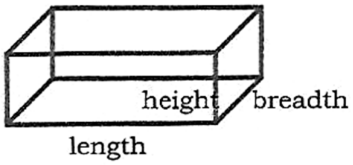
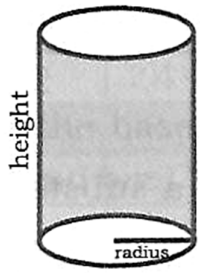
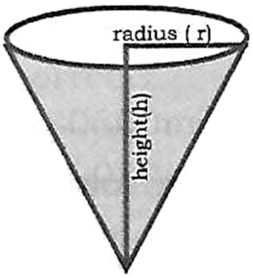


Over these blocks place more cubes so that height of block becomes 2 cm as shownin figure. Now count the number of blocks. It is found that total number of one-centimetre blocks is 12.

Thus, the volume of the blocks is equal to 12 × 1 cm^3 = 12 cm^3. However, if wemultiply length, breadth and height as under, the answer is again 12 cm^3.Length × Breadth × Height = 3 cm × 2 cm × 2 cm = 12 cm^3

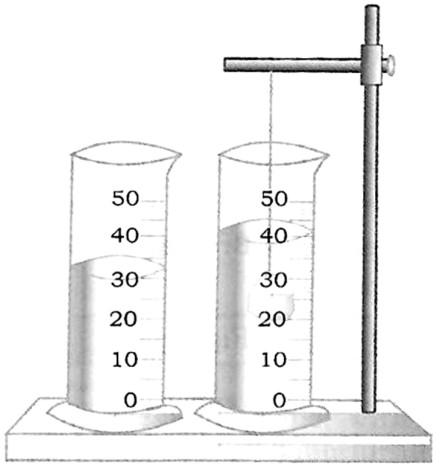
∴We can say. Volume = Length × Breadth × Height

Volume of some regular bodies:

S. No.	Regular body	Figure	Formula
1	Cube		Side × side × side
2	Cuboid		length × breadth × height
3	Cylinder		Area of cross section × height (h) $= \pi r^2 h$
4	Cone		$1/3\pi r^2 h$

Measurement of volume of a stone (An irregular body):

Take a measuring jar. Fill half of it with water and note the reading. Hang the stone to the stand with a thread. Arrange the measuring jar as shown in the figure so that stone is dipped in the water.



The water level raises in the jar. Note the raised level. The difference between two levels is the volume of stone.

To measure the volume of limestone which dissolves in water liquid like kerosene should be used. Limestone does not dissolve in kerosene.

SOLVED EXAMPLES

1. The water level of a measuring cylinder is 26ml. A piece of concrete having a volume of $6cm^3$ is immersed in it. The new level of water is

Sol. $\because 1ml = 1cm^3$

$6cm^3 = 6ml$

$\therefore$ The level of water

$= 26ml + 6ml = 32ml$

2. A vessel of 200gm weight is filled with some kerosene. If weight of the vessel with the kerosene is 270g, then how much kerosene is filled in the vessel?

Sol. Mass of kerosene $= 270g - 200g = 70g$

$\because 1g$ occupies $= 1cm^3$ volume of kerosene

Volume of kerosene $= 70cm^3 = 70ml$.

3. If 10 copper pieces, each of the mass 20g, are placed in the vessel with water, the level of water increases to 300ml in the vessel. Find the initial level of water in the vessel.

Sol. Total mass of all pieces $= 20 \times 10 = 200g$

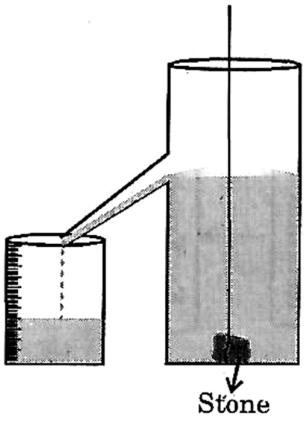
i.e., 200g mass displaces 200ml water in the vessel

Now, the present level of water in vessel = 300ml

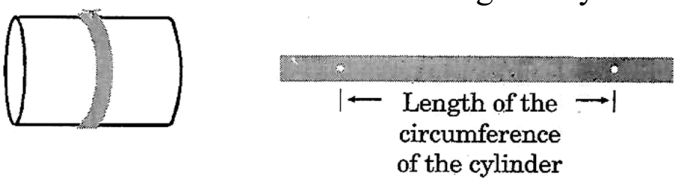
$\therefore$ initial level of water in the vessel $= 300 - 200 = 100ml$

4. How will you measure the volume of a stone by using an overflow can?

Sol. Fill the can with water to the level of spout. Immerse the stone in the can. The volume of water that overflows is the volume of stone.



5. How will you measure the circumference of a given cylinder?



A paper strip wrapped around the cylinder

Sol. Wrap a long strip of paper around the cylinder. Prick the paper by means of a pin. Remove the pin, unwrap the paper and measure the distance between two pricks by a scale. This gives the circumference of the cylinder.

3. MEASUREMENT OF MASS AND VOLUME

WORK SHEET LEVEL–I MAINS CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

MEASUREMENT OF MASS

1. The quantity of matter contained in a body is known as
   1) time 2) weight 3) mass 4) none
2. The unit of mass in C.G.S system is
   1) kilogram 2) gram 3) newton 4) dyne
3. Mass of substance can be measured more accurately by using
   1) common balance 2) spring balance
   3) sensitive balance 4) all of these

MEASUREMENT OF TIME

4. In all system of units, which of the following has same unit?
   1) mass 2) time 3) length 4) both 1 and 3
5. When you travel by bus, which quantity can be measured?
   1) time 2) length 3) mass 4) temperature

MEASUREMENT OF VOLUME

6. The space occupied by a substance is called_____
   1) Area 2) Length 3) Volume 4) None of these
7. Volume of rectangular glass slab of a regular body is_____
   1) length + breadth + height 2) length – breadth + height
   3) (length x breadth) + height 4) length × breadth × height
8. The S.I. unit of volume is
   1) Cubic centimetre 2) Cubic millimetre
   3) Cubic metre 4) Cubic litre
9. The space inside the container is known as its
   1) Mass 2) Weight 3) Capacity 4) None of these

LEVEL–II

MEASUREMENT OF MASS

10. The smallest unit of mass is
    1) milligram 2) gram 3) kilogram 4) atomic mass unit
11. One metric ton = _____ quintal
    1) 100 2) 10 3) 1000 4) 10,000
12. 1 Quintal(qt) = _____kg
    1) 1000 2) 1000 kg 3) 100 kg 4) 1000 kg
13. 1 micro gram(μg) = _____g
    1) 10^{-9} 2) 10^{-6} 3) 10^{-8} 4) 10^{-5}

MEASUREMENT OF TIME

14. Which of the following does not express a time interval?
    1) a day 2) a second
    3) a school period 4) time of the first bell in the school
15. Sundials do not work
    1) after sunset 2) on cloudy days 3) Both (1) & (2) 4) None of these
16. In a leap year, February has
    1) 28 days 2) 27 days 3) 29 days 4) None of these

MEASUREMENT OF VOLUME

17. The volume occupied by a cube whose each side is equal to 1 cm is called
    1) Cubic centimetre 2) Cubic millimeter
    3) Cubic metre 4) None of these
18. 1 litre =
    1) 1000 millilitre 2) 1000cc 3) both (1) and (2) 4) none of these
19. A cylinder is of length 7 cm and diameter 4 cm. The volume of cylinder is:
    1) 88 cm^3 2) 44 cm^3 3) 22 cm^3 4) none of the above

LEVEL-III ADVANCED CORNER

SINGLE CORRECT ANSWER TYPE QUESTIONS

20. Convert 10 quintals into micro grams (μg)
    1) $10^{12}\,\mu g$ 2) $10^{14}\,\mu g$ 3) $10^{9}\,\mu g$ 4) $10^{11}\,\mu g$
21. $10gcm^{-3}$=_____ kgm^{-3}
    1) 10^5 2)10^3 3)10^4 4) 10^{-2}
22. 1 second =_____ of mean solar day
    1) 1/3600 2) 1/86400 3) 1/6300 4) 1/68400
23. 1 mean solar day is equal to how many seconds?
    1) 86400s 2) 84600 s 3) 68400 s 4) 48600 s
24. 1 day = _____ sec
    1) 36,400 2) 43,400 3) 86,400 4) 56,230
25. A rectangular slab of volume is $12cm^3$. The length and the breadth is 3cm, 2cm. Then its height is
    1) 2cm 2) 2mm 3) 2m 4) none of these
26. A book of length 25cm, breadth 18cm and height 2cm. Then the volume of the book is
    1) 900 cm^3 2) 45 cm^3 3) 900 m^3 4) 45 m^3

STATEMENT TYPE QUESTIONS

27. Statement I: The smaller unit for measuring volume of liquids is millilitre.
Statement II: In standard international system volume is measured in cubic metre
1) Both Statements are true.
2) Both Statements are false
3) Statement I is true. Statement II is false.
4) Statement I is false. Statement II is true.

INTEGER TYPE QUESTIONS

28. 1 m^3 = _____ x 10^6 cm^3.

LEVEL-IV

MULTI CORRECT ANSWER TYPE QUESTIONS

29. The C.G.S unit of volume is
1) cm^3 2) c.c 3) cm^2 4) c.cm

30. 1 milligram = _____
1) 10^3 g 2) 10^6 kg 3) 10^{-3} g 4) 10^{-6} kg

COMPREHENSION TYPE QUESTIONS

PASSAGE

The volume of a cuboid = (area of the base) (height)

31. If length, breadth and height of cuboid are 20 cm, 18 cm and 15 cm, then its volume in M.K.S system is
1) 540 cubic metre 2) 5400 cubic centimetre
3) 640 cubic metre 4) 6400 cubic metre

32. If length breadth and height of cuboid are 3 m, 2.8 m and 1.2 m then its volume in C.G.S system is
1) 1008.00 cubic cm 2) 10080000 cubic cm
3) 10.08000 cubic cm 4) 100.80 cubic cm

33. If length, breadth and height of cuboid are 1 + x, 1 – x and $1 + x^2$, then its volume is
1) $(1 - x)^6$ cubic units 2) $(1 - x^{12})$ cubic units
3) $(1 - x^4)$ cubic units 4) $(1 - x^2)$ cubic units

MATRIX MATCH TYPE QUESTIONS

34.

Column-I		Column-II	
a)	Measuring flask	p)	Used to measure volume of liquids in millilitres
b)	Pipette	q)	Used for obtaining fixed amount of liquids
c)	Burette	r)	Used to deliver any required volume of liquid accurately.
d)	Measuring cylinder	s)	Used to measure height
		t)	Used to measure weight